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# U.S. DEPARTMENT OF AGRICULTURE - FOREST SERVICE

# MINUTES

# 1969 ZECTRAN PILOT TEST ANALYSIS

# NORTHERN REGION

Missoula, Montana

October 14-15, 1969

MINUTES

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Chairman John Milodragovich welcomed the group and stated that the objectives were (1) to evaluate the planning and field results of the 1969 Zectran pilot test, and (2) for the task force to provide recommendations on additional testing and the purchase of Zectran. A copy of the agenda, as revised by the group, is attached (Appendix II).

Persons present at this meeting will receive a draft copy of the minutes for review. Region 1 will compile the comments into a final draft. Milodragovich appointed a three-man committee consisting of Dave Ketcham, Bob McCulley, and Walt Cole to review this final draft before distribution to all participants.

## BACKGROUND INFORMATION ON 1969 TEST

A decision was made at the Aerial Survey Techniques Workshop last October that there should be a pilot test of Zectran in Region 1 at 2.4 ounces of Zectran per gallon of carrier and that Zectran should be purchased. We had a reasonable idea of the effectiveness of Zectran, and the 1969 test was to test application methods of the insecticide. We now have tested Zectran and application methods, and have the task of evaluating the effectiveness of Zectran and the application system used in the 1969 test.

Region 1 was requested by the Washington Office, November 21, 1968, to conduct a pilot test of Zectran in 1969. A planning meeting for the 1969 test was suggested by Region 1 and held in Ogden, Utah, January 30-31. At this meeting it was agreed Zectran would be applied when larvae were 50 percent in the fifth instar; check areas would consist of small points around the perimeter and within 2 to 3 miles of spray blocks. It was also decided a task force composed of Richard Washburn, Walter Cole, and David Fellin, INT; Carroll Williams and Gordon Mott, NE; Val Carolin, PNW; Patrick Shea, IEP; Fred Honing and Jerald Dewey, R-1; Galen Trostle and William Klein, R-4; and Jim Bean, Northeastern Area S&PF (NA) should set up criteria for establishing success or failure of the 1969 test and cover certain sampling criteria. It was decided by this task force to provide a complete sampling plan for the 1969 test. The plan stated that one prespray sample be collected the day before spraying, and two postspray samples 4 and 8 days apart following treatment. Intermountain Station and IEP would participate in test with coordinated fecundity and parasite studies.

## 1969 ZECTRAN PILOT TEST DISCUSSION

Criteria for selection of spray areas were:

1. Areas to be accessible by road.
2. Three intensities of defoliation present.
3. Multiple host species stands.
4. No excessive mortality of understory or top kill.

5. Elevational variation not greater than 1,000 feet.
6. Areas not to have been previously sprayed.
7. Easily accessible to C-47 aircraft.

Original plans were to spray four areas giving the following comparisons:

1 application, 0.15 lb. Zectran vs. 1 application, 0.075 lb. Zectran.

1 application, 0.15 lb. Zectran vs. 2 application, 0.075 lb. Zectran (= 0.15).

1 application, 0.075 lb. Zectran vs. 2 applications, 0.075 lb. Zectran using 2 reps each.

The four areas were to be selected as:

Two containing large numerical populations.

Two containing less than large numerical populations.

One prespray population check would be taken 24 hours prior to spraying. Postspray populations checks were to be taken at 4 and 8 days after spraying. An additional population sample was to be collected following pupation. Plot trees would be 30 to 40 feet tall and not be shielded by other trees.

Fish Creek was sprayed June 19 at a rate of 0.15 pound of Zectran in 0.5 gallon of TPM carrier per acre. Skookumchuck was sprayed twice--on June 21 and again on June 22--at a rate of 0.075 pound in 0.5 gallon of carrier per acre per application. One hundred and fifty trees were sampled in each spray block. Two 15-inch branches were taken from three crown levels. Branches occurring at each crown level were collected for weighting in the data analysis. Fish Creek prespray samples were collected on June 17, and postspray samples collected 4, 8, 12, 16, and 33 days following treatment. Skookumchuck prespray samples were collected June 18, and four postspray samples collected 4, 8, 12, and 31 days following treatment.

## Sampling Analysis

Residual populations (larvae per twig unit).

| | Area | Pre | Days after spraying 4 | 8 | 12 | 16 | Pupal |
|---|---|---|---|---|---|---|---|
| Treated | Fish | 47.58 | 0.34 | 0.31 | 0.26 | 0.24 | 0.04 |
| | Skookumchuck | 44.97 | .37 | .33 | .27 | -- | .05 |
| Check | Fish | 56.87 | .84 | .80 | .83 | .65 | .18 |
| | Skookumchuck | 26.37 | .80 | .68 | .47 | -- | .48 |

Percent mortality

| | Area | Pre | 4 | 8 | 12 | 16 | Pupal |
|---|---|---|---|---|---|---|---|
| | Fish | -- | 59.00 | 61.00 | 69.00 | 63.00 | 68.00 |
| | Skookumchuck | -- | 54.00 | 51.00 | 43.00 | -- | 89.00 |

NE Station personnel presented the results of the data analysis. The 80 percent budworm population reduction criterion of success, established by the task force at their February 18-19 Ogden meeting, was not achieved. Analysis showed that, with the exception of the last postspray sample (pupal sample) on grand fir in Skookumchuck, budworm mortality caused by Zectran was less than 80 percent. The reliability of all pupal samples was questioned since only the full pupal cases were tallied during a time when adult emergence was well underway in the field. The importance and the recognizable characteristics of the current year's empty pupal cases is presented in the sampling plan. The pupal data were clearly out of line with the larval data. Bud phenology and leaf pattern may have affected budworm mortality since it was higher on the earlier bud-breaking true firs than other species in both treated areas. There was no significant difference in budworm mortality between the area sprayed twice (Skookumchuck) and the area sprayed once (Fish Creek).

A reasonable explanation for the lack of difference in mortality between blocks is because the second application was within 24 hours of the first. If larvae escape the first insecticide application, the second application will be effective only if its application is delayed until protected larvae move to exposed sites. This was the basic reason for wanting spray applications separated by 4 days.

A question was asked concerning Zectran's residual effect. The effects of Zectran are immediate--within 5 minutes to one-half hour. However, the effect Zectran expresses on the spruce budworm can show up at a later date. It is necessary to evaluate ultimate effects (i.e., effects at pupal emergence) as well as immediate effects because compensatory survival may occur in the generation after the application of an insecticide. This tends to cancel the effects of the insecticide, and when it happens it is important to discover how much compensation occurs in order to determine whether lower levels of control at a late stage might be more effective in suppressing the population than high levels at an earlier stage. We are concerned with those moths which escape the insecticide applied, and this will be indicated by the pupal sample. The data were highly variable. An examination of the "t" ratios showed that budworm populations on Douglas-fir in Skookumchuck were the only ones in which survival was significantly higher than 20 percent. If the tree selection had been a random one as specified in the original sampling plan, we would be better able to test the survival ratios against the performance standard of 80 percent or greater mortality called for by the task force. It was pointed out that since the selection method did not include tree species in the sample in proportion to their occurrences in the stand, it is not valid to combine mortality figures for all species to obtain an average figure for the stand. Species proportion could be easily obtained by going to timber inventory maps of the areas, or if that wasn't accurate enough, returning to the plot trees and taking an inventory. Some system for randomly selecting trees in the field is needed in future tests.

Empty pupal cases were counted in one check area, but not in the other check area or the two spray areas. Several reviewers of the sampling plan submitted by the Insect Impact Project said the plan was the best written for a project of this kind. These reviewers included: Bill Waters, Chief,

Forest Insect Research; Gerald Walton, Statistician, NE, Upper Darby; Al Stage, Principal Mensurationist, Moscow; and Walt Cole, Project Leader, Insect Population Dynamics, Ogden, Utah. Project personnel agreed it was a very thorough plan, but impractical under the field conditions of this test.

## Field Application of Sampling Plan

The sampling plan called for four spray blocks, but due to limited time, rapid budworm development, and a shortage of insecticide, only two were sprayed. Availability of Zectran made it necessary to reduce size of area sprayed from 4,500 to 4,000 acres. Because of time involved in gridding and randomly selecting plots, rapid budworm development, and accessibility, plots were established on the basis of past projects. Plots were established along roads, trails, and flag lines, and no closer than one-tenth mile apart.

The feeling of those on the project was: Had the sampling plan been received sooner, areas accessible earlier, and budworm development "normal," application of the sampling plan as written may have been possible, but it would have required a much larger crew. Rapid budworm development necessitated a different method of selecting plot trees than spelled out in the sampling plan. NE Station personnel were contacted concerning the difficulties of the random plot selection method described in the sampling plan. They suggested a second method of first randomly selecting plots from points placed in a grid on the aerial photos of spray areas, then going directly to these selected points in the field. Subsequently, the second method suggested was not feasible because of the limited remaining time and the type of aerial photos available. Final method of plot establishment was decided upon by project personnel without further consultation with the authors of the sampling plan.

Field sampling was done by three crews of men and seven crews of women. Women worked equally as well as men for this sampling. Crews were supervised by entomologists and experienced technicians.

## Available Insecticide

Contact with the Sawtooth Forest indicated 73 barrels of Zectran were available for the pilot test. Approximately 1,000 pounds would be received from Dow Chemical. We actually received 46 barrels from the Sawtooth and 478 pounds from Dow. A decision was made by project personnel to spray the one block with 0.075 pound of Zectran 24 hours apart to equal 0.15 pound per acre. This decision was made because a storm front was moving into the area that probably would not have permitted spraying at a 4-day interval. This decision was based on the formulation and concentration of remaining insecticide. Remaining material was mixed at the 0.075 pound level.

## Aerial Spray System

The 700-gallon pressure vessel was mounted in a C-47 aircraft. It was built to withstand pressures up to 100 p.s.i. Freon was used to break up

the droplets and reduce their size. Nitrogen was used to expel the spray solution from the aircraft. Large 450-gallon tanks designed for insecticide concentration dilution and for insecticide and Freon 12 transfer were delivered to Grangeville to facilitate loading and speed up spraying time. A mobile, engine-driven air compressor was used to transfer the insecticide and Freon 12 from the transfer tanks into the aircraft insecticide tanks.

The droplet spectrum of atomized insecticide sprayed from the airplane was 10 to 120 mμ. From 300 feet, in tests flown over a runway at Missoula, spray took approximately 10 minutes to settle. However, the spray cloud persisted beyond 10 minutes. Droplet size was checked during the runway test on magnesium-oxide coated slides. In using magnesium-oxide coated slides, droplets were extremely difficult to measure due to the erratic craters made as drops strike the coating on the slides. Drops 50 mμ mmd or smaller on budworm webbing disappeared (evaporated) within 5 minutes in the laboratory.

A general discussion was initiated concerning spray assessment methods. We need to know how much spray reaches the ground. This has been measured by drop cards, slides, or by use of a biological indicator. If mortality from a given amount of insecticide is unknown, a bioassay cannot be made. Metronics Corporation in California now has fluorescent particles available to assess spray droplets down to 10 mμ mmd; and laser holography could be set up in the field for observation of spray droplets.

The possibility of using Krome-Kote cards was discussed. The nonuse of Krome-Kote cards may have been premature. Cards are now available that can be washed for analytical assessment and also drop size can be measured. A correlation between droplet numbers and spruce budworm mortality was found in 1965 and 1966 using Krome-Kote cards, according to Buffam.

## Development Sampling

Devlopment samples were taken June 2, 3, 4, and starting June 9, every day up to spray day. Development data were grouped by tree species. The same trees were not sampled and, as a result, a proportional representation of hosts in the stand may not have been sampled. Instar determinations were made by measuring head caps using a dissecting scope in the laboratory. A woman, trained and supervised by an entomologist, made the determinations.

The methodology used by the project in the development sampling was questioned. A portion of the minutes concerning "development sampling" from the spruce budworm planning meeting held in Ogden in February was read:

> Development sampling.--Development sampling should begin about 2 weeks after the budworm has broken dormancy (near mid-June).
>
> Around 10 points per area should be sampled daily for development. This number may be reduced or increased when it is

determined how much variability there is in each area. At least one tree of each species per point should be sampled at midcrown and should include at least four 15-inch branches per tree--preferably 100 larvae per tree per point.

Development samples should be taken and treated the same as prespray and postspray samples to give the crews experience. Development samples should not come from the same trees as prespray and postspray samples. Development samples will be taken to the laboratory and checked by a crew of women. An entomologist or well-trained, responsible technician, should be assigned to the laboratory and frequently check the women's work to make certain they find all larvae. The laboratory entomologist or technician will be responsible for instar determinations. Carolin's instar characteristic chart can be used for late instar separations, with periodic head capsule measurements as a check. Head capsule measurements will be made during early instar development. The project entomologist should know, each day, the stage of development for each area.

Spray days will be projected prior to the time 50 percent of the larvae have reached the fifth instar. Spray days will be projected at least 48 hours in advance to allow for prespray sampling. Spraying should be completed before pupation occurs.

Budworm development was rapid from May 23 to mid-June.

## Weather Information

From May 1 through June 15, temperatures in the two areas averaged from 4° to 15° higher than the 10-year average for this same period of time. Precipitation averaged 0.65 inch less during May and 2.0 inches less during June 1-15 than the previous 10-year average for the same period of time. From June 15 through July 1, the 10-year average maximum daily temperature was 7° higher than that which occurred in 1969. Precipitation from June 15 through July 1 was 0.40 inch and 0.80 inch higher in Fish Creek and Skookumchuck respectively than the previous 10-year average for the same corresponding period. In brief, it was much hotter and drier than the 10-year normal up to spray day, and considerably colder and wetter after spraying.

On June 19 when Fish Creek Was sprayed, good weather conditions prevailed; in Skookunchuck the first day was excellent, the second day was good until 9 a.m. It began to rain and continued throughout the day. Rain and snow fell throughout the collection of most of the postspray samples. The storm persisted for almost 2 weeks.

## Laboratory Operations

The objectives involved the prompt examination of prespray and postspray foliage samples for budworm counts and the rearing of budworm subsamples for the related parasite and fecundity studies. The laboratory was set up in a warehouse at Grangeville, with 37 foliage examiners supervised by an entomologist. Foliage was stored in two refrigerated vans until examination. Three to five experienced seasonals helped with rearings and budworm counts. Women were responsible for counting defoliated and nondefoliated buds, measuring dimensions of branch sample, removing larvae and pupae from sample, and putting them into Petri dishes. These women were trained on practice samples.

A written summary of laboratory activities was distributed to participants and task force members.

## Parasite Studies

IEP data strongly indicates an increase in incidence of parasites per 100 budworm larvae after the application of Zectran, particularly *Glypta* and *Apanteles*. Number of parasites per 100 budworm larvae were determined by sampling from different hosts. The budworm were reared on artificial media in Petri dishes to obtain the budworm-parasite ratio. Data from the 1968 Belmont and Chamberlain Creek project indicated that parasites per 100 budworm larvae continued to increase 1 year following spraying.

It was hypothesized that reasons for an increase in parasite ratios were:

1. Parasitized larvae are less active, and at the time Zectran is applied they are less apt to come in contact with the insecticide.

2. Parasitized larvae are less active, and Zectran is not metabolized.

In the 1965 Zectran and Naled test on the Bitterroot National Forest there appeared to be a threefold increase in number of parasites with Zectran, but no increase in parasite ratios with Naled. Budworm mortality differed by forest type which also influenced parasite ratios.

It is believed that with Zectran we are approaching integrated control as far as spruce budworm is concerned.

## Fecundity Study

Under laboratory conditions, IEP reported sublethal topical dosages of Zectran applied to spruce budworm resulted in less eggs being layed. The objectives of the study were:

1. Does Zectran applied in the field affect fecundity of surviving females?

2. Does host tree affect fecundity?

Larvae receiving no insecticide in the treated area would be confounded with treated larvae selected for the fecundity study. The amount of food received by larvae prior to acquisition in the laboratory may have influenced fecundity.

Pupae were sorted into Petri dishes at the Missoula insectary. Adults were mated and paired by host tree species, crown level, and size of pupae. Adults were left in cardboard mating chambers for 10 days. Emerging larvae were counted and data analyzed. A summary follows:

1. Regression line for number of eggs over size of individual from check material pooled from Skookumchuck and Fish Creek were fairly constant regardless of host trees.

2. Regression for treated material was lower than check area for small individuals and higher for larger individuals. No explanation is postulated.

3. In Skookumchuck, where samples were taken at 4- and 8-day intervals, there was only a slight difference. The regression line for each host was discrete but close together.

4. Higher fecundity, at least for larger individuals in treated areas with rating as follows: subalpine fir > grand fir > Douglas-fir.

5. Some indication that budworm from spruce was less fecund than individuals from other hosts.

## Egg Mass Characteristics

It would be useful to have a field measure of the effects of sublethal dosages on the fecundity of surviving females. It was hypothesized that if sublethal dosage affected fecundity, it could also affect egg laying behavior, which might be manifested in differences of egg mass characteristics. Therefore, the study dealt with the measurement of the length and number of rows in field-collected egg masses. Sample trees were selected in both spray areas proportional to the probability of the species in the stand. Plots were located near center of spray areas to reduce influence from inflight. Samples consisted of a 36-inch branch or an entire branch if less than 36 inches from each of three crown levels.

No difference was found between any egg mass characteristic in length or width either by host or area. A significant difference was found in egg mass width on grand fir in Fish Creek from all other areas. Sufficient information is available that may aid pest control entomologists in sampling grand fir and subalpine fir for budworm egg masses. Data on egg mass density by crown level are being analyzed and will be available later. More egg masses were found on Douglas-fir than on grand fir. It is important that to date no difference in egg masses were found between checks and sprayed areas. Because of the apparent variation of mortality within the spray boundaries and the overall low mortality, it was not possible to say whether sublethal dosages of Zectran would or would not cause differences

in egg mass characteristics. All that could be concluded was that data from this test did not reveal any significant differences between treatment and checks.

## History of Zectran Use

During 1964, Zectran was applied at one-tenth pound per acre with seemingly good results in the Salmon National Forest, Idaho. In 1965, Zectran was applied at 0.12 pound per acre in a gallon of solution--10 percent methylene chloride, 90 percent cycle oil. Material was applied with a helicopter equipped with Mini-Spin nozzles. Fluorescent particles were used for tracing. Zectran was applied both in early morning and late evening. Mortality was 97 percent in morning spraying and 85 percent in evening application.

During 1966, Zectran was applied at 0.15 pound of Zectran in 1 gallon (10 percent DB plus 90 percent deodorized kerosene) per acre. A Ford Tri-motor was used to spray most of the area, but a helicopter was used to spray one stream. T-jet nozzles were used. Mortality on one 5,000-acre plot in Trapper Creek was 87 percent and 77 percent in a 1,000-acre plot in Laird Creek.

Fish and Wildlife personnel working with the Forest Service in 1966 had one stream sprayed by helicopter two times and one area sprayed five times. No adverse effects were indicated.

The Sawtooth test in Idaho during 1967 was reduced to 2,000 acres due to budworm population collapse. Mortality was about 77 percent after spraying.

Zectran was applied at a rate of 1 ounce in 1 pint of Dowanol per acre at a droplet size of 120 microns or less in 1968. Mortality was 70.0 in Belmont Creek and 47 percent in Chamberlain Creek. A TPM-Freon system was used in a C-47 aircraft. Air transport (inversion) was used for spraying the Chamberlain area, but swathing was used in Belmont Creek.

Zectran in cycle oil was applied to tussock moth in 1965 in Oregon with only 10 percent mortality resulting.

In 1968, 500 acres infested with hemlock looper were sprayed with 0.2 pound Zectran in 2½ pints of carrier per acre. Mortality was 20 percent.

During 1967 in Maine, Zectran was applied at 13 fluid ounces per acre in Dowanol-TPM to 500 acres infested with budworm. Population reduction was 82 percent assessed 3 days after spraying.

Many nontarget insects are not affected to any great extent by Zectran. However, bees and other Hymenopterans--such as sawflies--are highly susceptible to Zectran. Honey bees can be protected by restricting them to their hives during spraying. Since Zectran is a nonpersistent insecticide, the bees can be released 6 to 8 hours following spraying.

A publication by a private research organization under contract with the Department of Health, Education and Welfare did not show that Zectran was

tumor inducing. However, it listed Zectran with several other experimental compounds which would require additional evaluation.

Tests of Zectran made by chemists at Dow Chemical Company produced no tumorous effects.

During 1966 Zectran proved much more effective than Naled in killing *Choristoneura occidentalis* larvae, and was more specific than Naled. *Choristoneura occidentalis* populations were reduced to a much greater extent than most populations of associated insects. Other than *C. occidentalis* populations, sawflies were next most affected by Zectran.

Zectran has been applied at a different rate and different application method every year. In 1965-66 the best mortality was obtained with larger droplets and more carrier. Small drops may have evaporated before they reached the target insect.

The following is based upon discussions held in Ottawa September 29, 1969, at which the following were present:

| | |
|---|---|
| J. J. Fettes - Head, Chemical Control Research Institute | ) Canada Depart- |
| W. A. Reeks - Program Coordinator of Entomology | ) ment of |
| A. P. Randall - Staff, Chemical Control Research Institute | ) Fisheries and |
| J. Armstrong - Staff, Chemical Control Research Institute | ) Forestry |

The following is a memorandum to John Milodragovich, Chief, Division of State and Private Forestry, Region 1, from J. L. Bean, NA-S&PF, and D. G. Mott, NE, concerning the Canadians' experiences with Zectran:

"Field tests of Zectran against spruce budworm by the Chemical Control Research Institute (CCRI) in Canada have been carried out in 1965, 1966, 1967, and 1969, and have involved a variety of formulations, application methods, dosages, and timing of applications.

"The basic experimental field test utilized by CCRI in most of these insecticide trials consists of a 400-acre block in which a deliberately graded deposit rate is applied. Samples for insecticide deposit and insect survival are drawn from sampling points distributed systematically along plot transects normal to spray swaths. Insect counts are obtained from 18-inch branch samples drawn from upper and middle crown thirds, and density is calculated as insect numbers per 100 or 1,000 buds. Spray deposit is assessed on white Krome-Kote cards with dyed spray material (assessment of number of droplets 30 mμ per square cm.) and on glass slides which are analyzed colorimetrically (assessment of volume of deposited material per unit area). Application rates (deposit rates) are deliberately graded in such experiments in order to ascertain optimum application rates.

"All analyses of results utilize mortality rates corrected for natural mortality on check trees. As a result, the mortality rates reported herein will be lower than those conventionally reported in USFS results.

"The experiments with Zectran before this year involved tests which ranged over several types of spinning-cage emission devices (Turbairs, Mini-Spins);

"applications very early in the larval development period to ascertain whether any systemic effect could be obtained against second instar mining larvae, concentrations ranging from about 5 percent to 25 percent and a variety of dosage rates. These experiments produced results that suggested there was not likely to be any systemic effect although one trial involving applications on May 21 against second instar populations did yield mortality in the 40 percent area at some dosage rates. Applications against populations in later stages of development indicated that high levels of control could be obtained with dosages in the vicinity of 1 to 2 ounces per acre using equipment available operationally. As a consequence, expanded trials were conducted in 1969.

"These consisted of two 2,800-acre operational blocks and two 400-acre experimental blocks designated respectively 12 and 13; and 2 and 8.

"Two applications, 4 days apart, of material consisting of 1 ounce of Zectran in 19.2 ounces liquid per acre per application (2 ounces per acre total application) were used in plots 12, 13, and 8. Plot 2 was treated once on May 22 when larvae were well protected in mines in needles. (It is believed that the dosage rate on plot 8 was 13 ounces of formulation per acre per application.)

"Plots 12 and 13 were treated June 4 and 9 when larvae were about 50 percent third instar, foliage on balsam fir had just 'flared' and larvae on spruce (red, black, red and black, and white) were well protected under bud caps covering devloping shoots. Applications were made by three TBM (Grumman Avengers) flying in tandem at 150 m.p.h. equipped with boom and No. 8006 (or 8010) 'flat fan,' 45° forward nozzles, with 40 p.s.i. pressures. This particular configuration is known to produce an emission spectrum with about 200 mμ mmd and deposit rates in terms of droplets per square cm. that range at least to 35. (Early work with DDT and a broad experience with other insecticides by the Chemical Control Research Institute has revealed that providing sufficient insecticidal toxicity is provided in spray formulations, good control results are usually secured when application devices are used which provide deposit rates of 15 to 20 droplets per square cm. (as measured on Krome-Kote cards; i.e., diameter > 30 mμ)).

"Plot 8 was treated on June 17 and 21 when development had advanced to include substantial proportions of sixth instar larvae, and the population was feeding in considerably better exposed sites than in the earlier treatments. Applications were made using Micronair spraying cages.

"The timing of applications of plots 12 and 13 is typical of that used in New Brunswick where foliage protection is the objective; the timing on plot 8 is more representative of that adopted in the United States.

"Considerable detail was provided by CCRI personnel in discussing the results of the trials. The essence of the results were as follows:

"1. Percentage mortality increased with increasing deposit as measured by the number od droplets per square cm.

"2. Overall average percentage control with corrections for natural mortality is as follows:

| Time (days) relative to 1st spray application | Plot 2 Fir | Plot 12 Fir | Plot 12 Spruce | Plot 13 Fir | Plot 13 Spruce | Plot 8 Fir |
|---|---|---|---|---|---|---|
| 4 | 0 | 42 | 18 | 22 | 63 | |
| 7 | | | | | | 97.5 |
| 9 | 0 | 90 | 54 | 71 | 69 | |
| 10 | | | | | | 97.0 |
| 14-15 | 0 | 95 | 25 | 65 | 65 | |

"It seemed that the difference on fir between plots 12 and 13 was due to different amounts of deposited material (one might speculate that the differences in the spruce results were due to developmental differences, but it might reflect small samples as well).

"A general discussion of the merits of Zectran revealed that the opinions of the CCRI were:

"1. Zectran was eminently suitable as an insecticide for use against spruce budworm. Its advantages were that it produced high rates of mortality (in comparison with other insecticides) at low rates of deposit (droplets per square cm.); it possessed a high toxicity against sixth instar larvae, and it apparently satisfies most of the requirements of an ecologically acceptable insecticide in terms of its persistence and hazard to other biotic systems. Its disadvantages consist of its currently high cost.

"2. Sumithion is currently an acceptable material with the advantage as a control agent over Zectran of possessing some systemic effects for early spraying, and a substantially lower cost. Its hazard to bird populations is a disadvantage.

"3. In choosing an insecticide for population control, it seemed to be the opinion that Zectran would be utilized; for foliage protection and early spraying, Sumithion would be selected (if cost is ignored).

"4. If Sumithion is found to be unacceptable for any reason, there is not currently available any satisfactory alternative. Zectran appears to constitute such an alternative."

The only disadvantage of Zectran was the high cost.

A letter from Fettes was read stating the following:

"1. Zectran was sprayed over some 6,000 acres at 2 ounces per acre in one-fifth gallon of formulation. Coverage was very good and the weather

"conditions were excellent. Equipment was boom and nozzle (fine flat fan) and control was not overly impressive at approximately 70 percent.

"2. Other experimental plots of Zectran applied at 2 ounces per acre using Micronair spinning cages produced fine breakup (approximately 125 $\mu$ mmd). Breakup approached the ULV size spectrum and apparently gave excellent control (95 percent approximately)."

Sumithion has been considered as an alterative over DDT. It does have some systemic effect, costs less than Zectran, but is harmful to birds, and is somewhat persistent.

During the discussion of the Canadian experience, a question was asked about the apparent difference in interpretation of the results of the 6,000-acre treatment and the letter from Fettes. The value of 70 percent represents a figure corrected for natural mortality, and is thus lower than the usual figure calculated in United States tests; that 70 percent is a remarkably good figure considering that the material was applied near peak III instar and involved one-fifth gallon per application. The value of 95 percent (again corrected for natural mortality) was obtained in plots treated at a time more nearly in accord with United States practice.

NE Station personnel stated that the toxicity of Zectran on spruce budworm is unquestionable. It is 100 times more toxic to sixth instar spruce budworm than DDT, far less persistent than DDT, short-lived in field. Sumithion and DDT are known to have deleterious effects, where Zectran doesn't. The group should take the attitude of purchasing Zectran for suppression of spruce budworm.

Our first endeavor should be to search literature to find if there was any indication of side effects of Zectran on environment.

The spray pilot indicated that percentage of budworm survival should be higher on ridgetops and in draws on the Grangeville project, which may be attributed to air temperature gradients, along with the small spray droplet size used. Therefore, by increasing the droplet size, survival would be less in these areas because the spray would not be carried as easily by the normal air currents.

The following chart was put on the board for a comparison of Zectran tests and history:

| Trial | Equipment | Control[1/] | Dosage | Spectrum[2/] | Deposit[3/] |
|---|---|---|---|---|---|
| 1965 IEP & PC | Helicopter | High | 0.12 lb. Zectran 1 gallon | Medium | High |
| 1966 IEP & PC | Ford Tri-motor and Helicopter | Med.-High | 0.15 lb. Zectran 1 gallon | Medium | High |
| 1967 IEP | Bi-fluid | Med.-High | 1 pint | Very fine | Yes |
| 1967 Maine | Helicopter | Medium | 0.15 lb. Zectran 13 ounces | Fine-Med. | Low |
| 1968 PC | C-47 | Low | 1 oz. Zectran 1 pt. per acre | Very fine | ? |
| 1969 PC | C-47 | Low | 1/2 gallon | Very fine | ? |
| 1969 Canada | Flat-fan TBM | Med.-High | 19 ounces | Medium | High |
| 1969 Canada | Turbair | High | 13 ounces | Fine-Med. | High |

1/ Control: High = over 90 percent; med.-high = 85-90 percent; medium= 80=85 percent; low = less than 80 percent.

2/ Spectrum is classified in accord with what is expected using the given equipment, and is a relative ranking only.

3/ Deposit is a subjective evaluation in some cases of what could be expected given the dosage rate and spectrum, and in some cases, reflects actual measurement.

An examination of the table reveals that when deposit is high, control rates are high.

## GENERAL DISCUSSION

Discussion was then initated toward the function of the task force. The responsibilities of the task force were discharged by merging it with the present meeting.

The criteria set up for Zectran by the task force at the February 18-19 meeting in Ogden, Utah, were brought out. These were degree of population reduction, surviving number of insects, effect on parasite abundance, effect on budworm fecundity, effects on other animals, residual effect of Zectran, and selectivity.

The performance standards were acceptable bases for decisions about Zectran in the present climate of concern about insecticides, when a suitable insecticide was obviously needed for use against budworm, and when the effectiveness of the material was so well established by laboratory tests and other field trials. Eighty percent population reduction is in no way final as a standard for control programs. Experiences with spruce budworm control on this continent have not been analyzed; thus, a brief for any particular target value cannot be held.

A discussion was then initated about alternative insecticides other than Zectran. The only others that had been tested were Sumithion and Phosphamidon. Both gave 90 percent plus control. Bird kill was minimum when using Phosphamidon at 6 ounces or less per acre. Other materials have not been field tested to the extent of Zectran.

If we have Zectran stockpiled, and find a better material, there is no reason we cannot continue to use Zectran.

An opinion was expressed that we may be better off to use Sumithion because it is less expensive than Zectran, and if the Forest Service stockpiles Zectran there is no assurance land managers would use it due to high costs.

Some feel that Zectran is the only material that offers promise as an ecologically acceptable insecticide for control of spruce budworm.

Sumithion is being used at its upper dosage limits already, whereby the upper limits of Zectran are unapproached.

Two questions were raised for future consideration in budworm research:

1. What are the deleterious effects of spruce budworm on the host ecology?

2. What are possibilities of developing a herbicide to upset the food supply of spruce budworm?

Dow's part in the production of Zectran was discussed. Dow Chemical has no more Zectran available; thus, the smallest production unit would be 350,000 pounds and 12 to 18 months before Zectran would be available. Once the plant is set up, Zectran will probably cost between $10 to $15 per pound. There would be no problems with registration of Zectran.

Zectran should be produced with the possible need for budworm suppression in mind, and that it is an ecologically acceptable material available to society. There is ample precedent for involvement of governmental agencies to fulfill the role of cooperation with private industry.

We need a deadline of urgency to proceed as rapidly as possible with Zectran.

Other agencies besides the new lab at Corvallis should participate in testing spray systems.

## RECOMMENDATIONS

1. That a thorough examination be made of all research and experiences with Zectran in order to ensure that all requirements of a satisfactory insecticide against the spruce budworm will be met, that there is no evidence of possible deleterious effects from the use of Zectran, and that a formal report of the findings be prepared before any further action is taken by the Forest Service.

2. That Director McCulley appoint IEP personnel to take leadership in accomplishing Recommendation 1, and that the Washington Office Divisions of Forest Pest Control and Forest Insect Research and Disease Research should closely assist by recommending individuals from their groups to assist and suggest contacts within the Bureau of Sports Fisheries and Wildlife or other knowledgeable people.

3. That our agency faces an urgent social responsibility in any situation where there are clear and imminent dangers from the use of ecologically damaging insecticides, and where there are equally clear and imminent risks of serious losses in the Nation's natural resource supply. The Forest Service has this dual responsibility of environmental and resource value protection.

It is our position that whereas: (a) Zectran is an effective insecticide for use against spruce budworm, and (b) Zectran offers promise of causing no environmental damage; we recommend that the Forest Service take steps to assure the continued availability of Zectran for application against spruce budworm and possibly other forest insects (provided the results of Recommendation 1 are favorable). Following registration, we recommend Zectran be purchased.

4. That the system now at MEDC, excepting the use of Freon, be used to apply Zectran aerially at a dosage rate of 0.15 pound per gallon of carrier per acre. The carrier will be 10 percent DB plus 90 percent deodorized kerosene.

5. That we recognize an urgent need for improvement in our methods of aerial application of chemical and biological insecticides. Therefore, this group recommends that the Forest Service place a high priority on research and development of more efficient methods for aerial application of insecticides and evaluation of spray deposit.

David Ketcham summarized the meeting by saying he thought it was productive and that Pest Control and Research should coordinate where possible and work closely together with outside agencies. He said that recommendations made by the group would definitely be passed on to those concerned in the Washington Office.

APPENDIX I

## ATTENDEES

1969 Zectran Pilot Test Analysis
October 14-15, 1969

| | | |
|---|---|---|
| David E. Ketcham | Forest Pest Control | Washington, D.C. |
| John R. Milodragovich | Division of S&PF | Missoula, Montana |
| Harvey V. Toko | Division of S&PF | Missoula, Montana |
| Frederick W. Honing | Division of S&PF | Missoula, Montana |
| Mark D. McGregor | Division of S&PF | Missoula, Montana |
| Wayne E. Bousfield | Division of S&PF | Missoula, Montana |
| Jerald E. Dewey | Division of S&PF | Missoula, Montana |
| Samuel S. Evans | Division of TM | Missoula, Montana |
| Charles R. Whitt | Division of R&W | Missoula, Montana |
| Albin C. Hammond | Division of Fire Control | Missoula, Montana |
| Frank A. Borgeson | Division of Fire Control | Missoula, Montana |
| Farnum M. Burbank | MEDC | Missoula, Montana |
| Ernest W. Amundsen | MEDC | Missoula, Montana |
| Arthur J. Mattila | MEDC | Missoula, Montana |
| Anthony Jasumback | MEDC | Missoula, Montana |
| Albert W. Bellusci | MEDC | Missoula, Montana |
| Lynn Marsalis | MEDC | Missoula, Montana |
| Fred B. Olness | Nezperce NF | Grangeville, Idaho |
| Dale O. VanDenburg | Northeast Area S&PF | Upper Darby, Penn. |
| John F. Chansler | Northeast Area S&PF | Amherst, Mass. |
| D. Gordon Mott | Northeastern Forest Exp. Sta. | Hamden, Connecticut |
| Carroll B. Williams | Northeastern Forest Exp. Sta. | Hamden, Connecticut |
| Paul Buffam | Region 3 | Albuquerque, New Mex. |
| Harold Flake | Region 3 | Albuquerque, New Mex. |
| Bruce H. Baker | Region 4 | Ogden, Utah |
| Peter W. Orr | Region 6 | Portland, Oregon |
| Walter E. Cole | Intermountain Forest and Range Exp. Sta. | Ogden, Utah |
| David G. Fellin | Intermountain Forest and Range Exp. Sta. | Missoula, Montana |
| Richard I. Washburn | Intermountain Forest and Range Exp. Sta. | Moscow, Idaho |
| Bohdan Maksymiuk | Pacific Northwest Forest and Range Exp. Sta. | Corvallis, Oregon |
| Robert D. McCulley | Pacific Southwest Forest and Range Exp. Sta. | Berkeley, California |
| Raymond P. Miskus | Pacific Southwest Forest and Range Exp. Sta. | Berkeley, California |
| Patrick J. Shea | Pacific Southwest Forest and Range Exp. Sta. | Berkeley, California |
| Robert Harrison | Dow Chemical | Midland, Michigan |

## APPENDIX II

## 1969 ZECTRAN PILOT TEST ANALYSIS

Chairman: John R. Milodragovich

| | |
|---|---|
| I. INTRODUCTION | Milodragovich |
| A. Background planning | Toko |
| II. ANALYSIS OF 1969 TEST | |
| A. Area selection | Honing |
| 1. Entomological considerations | |
| 2. Logistical considerations | |
| B. Planning | |
| 1. Coordination with supporting activities | |
| a. Sampling plan design | Williams |
| (1) Past and present | Williams |
| (2) Field application | Dewey |
| C. Spray operations | |
| 1. Insecticide | |
| a. Availability | Honing |
| 2. Spray aircraft and spray systems | Bellusci |
| D. Field phases | |
| 1. Development sampling | Honing |
| 2. Weather factors before, during, and after spraying | Dewey |
| 3. Field sampling | Flake |
| 4. Laboratory | Baker |
| E. Planning and results of 1969 test | |
| 1. Assessment of larval mortality | Williams |
| 2. Parasite study | Shea |
| 3. Fecundity study | Fellin |
| 4. Adult survival study | Washburn |
| III. TASK FORCE RECOMMENDATIONS | |
| A. Summary of past Zectran tests | Miskus |
| B. Summary of 1969 Canadian test | VanDenburg, Mott, Chansler |
| C. Task force function | Mott |
| 1. Performance standards | |
| IV. SUMMARY | Ketcham |